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U.S. PATENT DOCUMENTS

4,176,929 12/1979 Ito et al. 354/29

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2843941	4/1979	Fed. Rep. of Germany .
52-147776	12/1977	Japan .
53-3261	2/1978	Japan .
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54-161326	12/1979	Japan .

Primary Examiner—Michael L. Gellner
Attorney, Agent, or Firm—Weinstein & Sutton

[57] **ABSTRACT**

An integrating time detector derives an integrating time interval within a reduced period of time, by decreasing a reference voltage against which an integrated voltage is compared in accordance with a time function stored in a computer.

14 Claims, 6 Drawing Figures

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[30] Foreign Application Priority Data

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[51] Int. Cl.³ G03B 7/093

[52] U.S. Cl. 354/23 D; 354/51

[58] **Field of Search** 354/23 D, 51

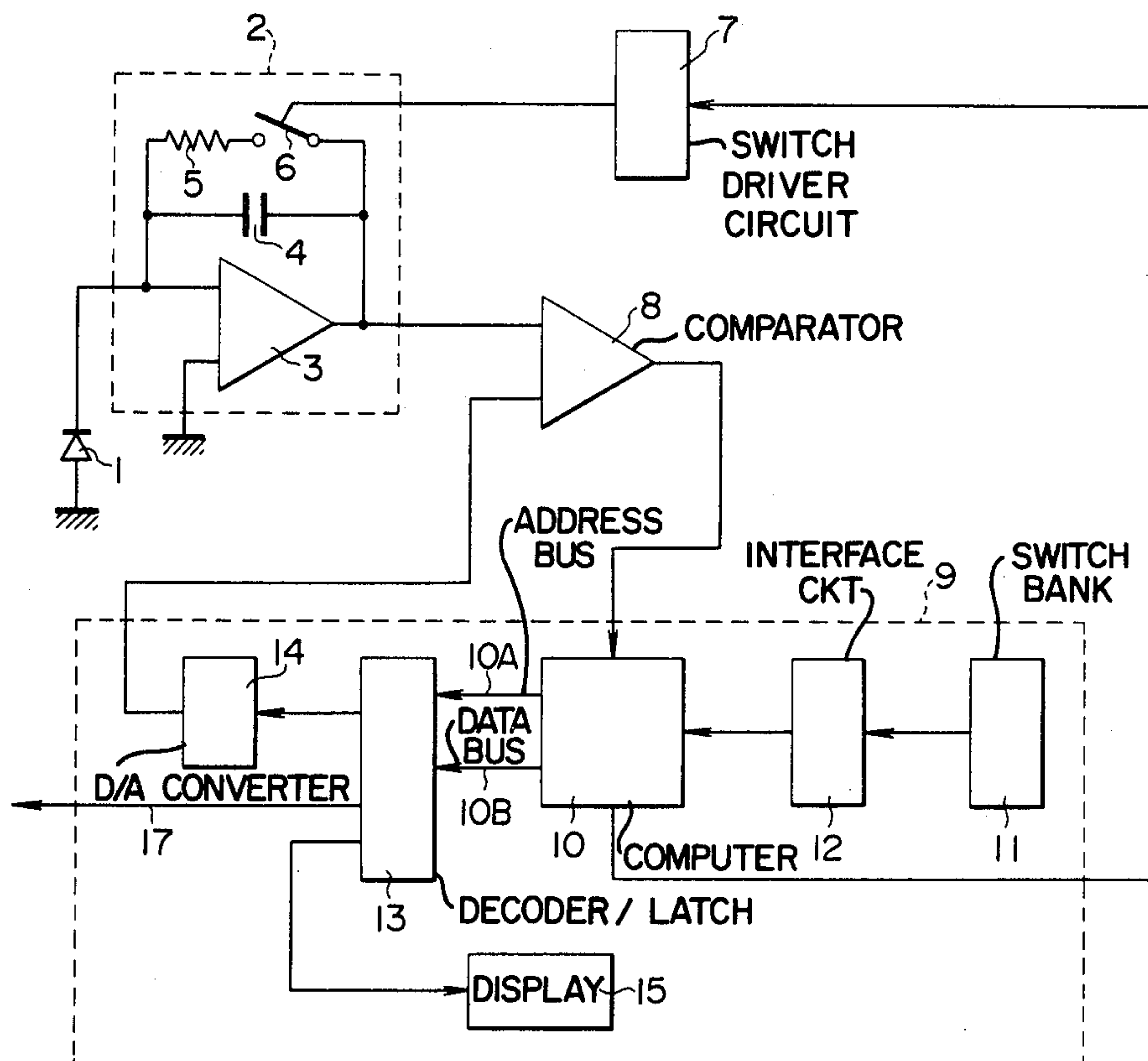
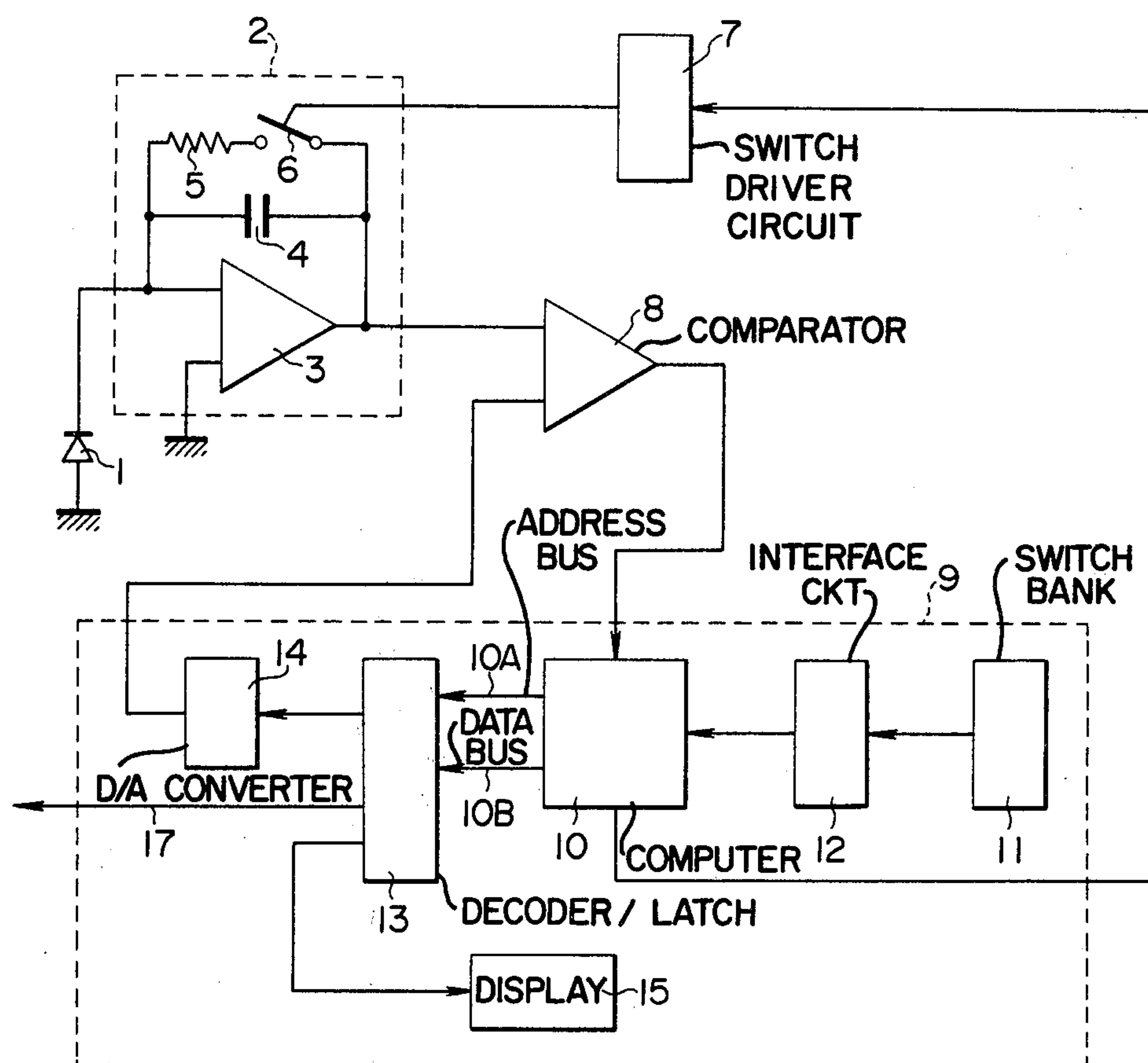


FIG. 1



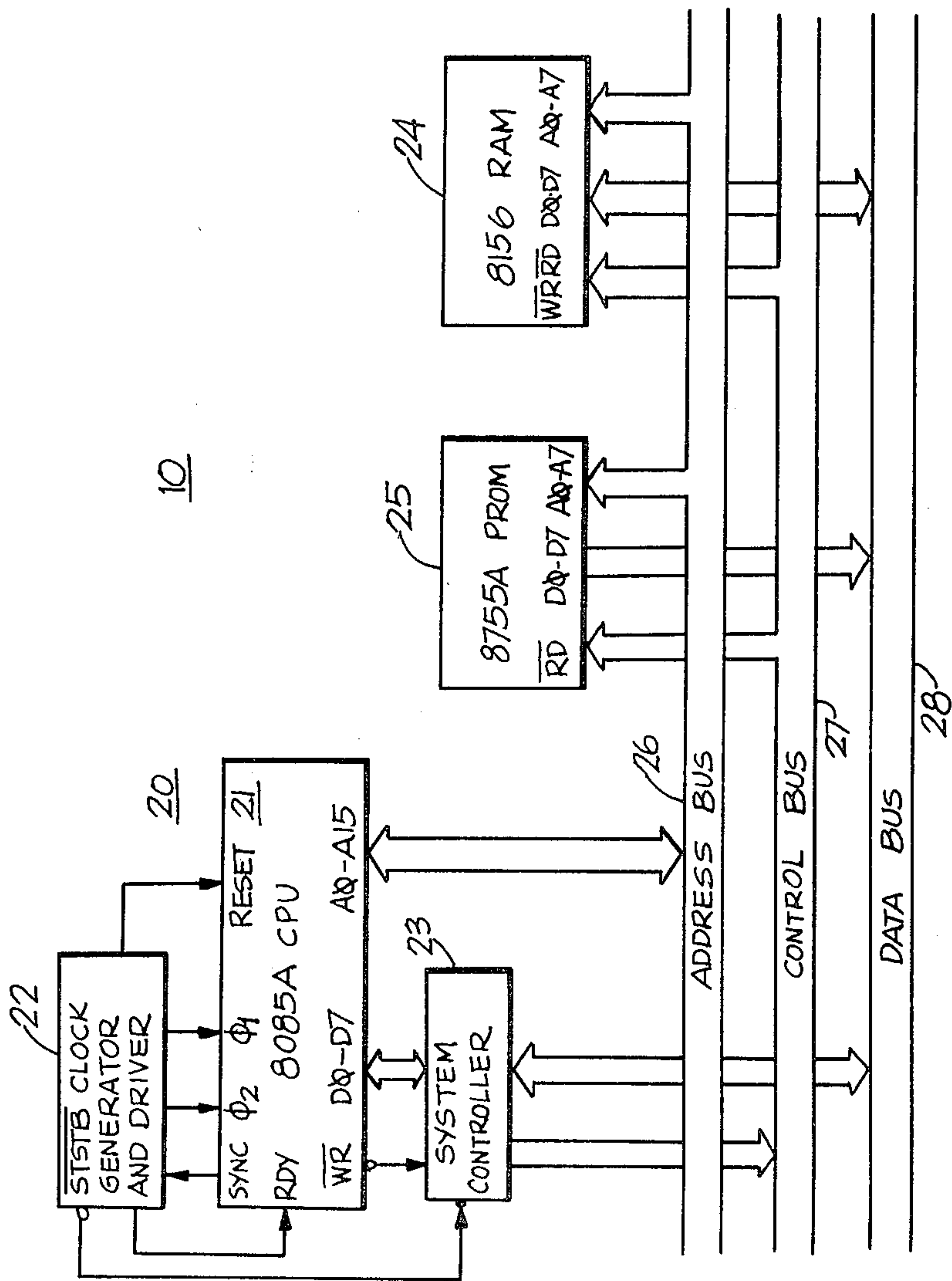


FIG. 4

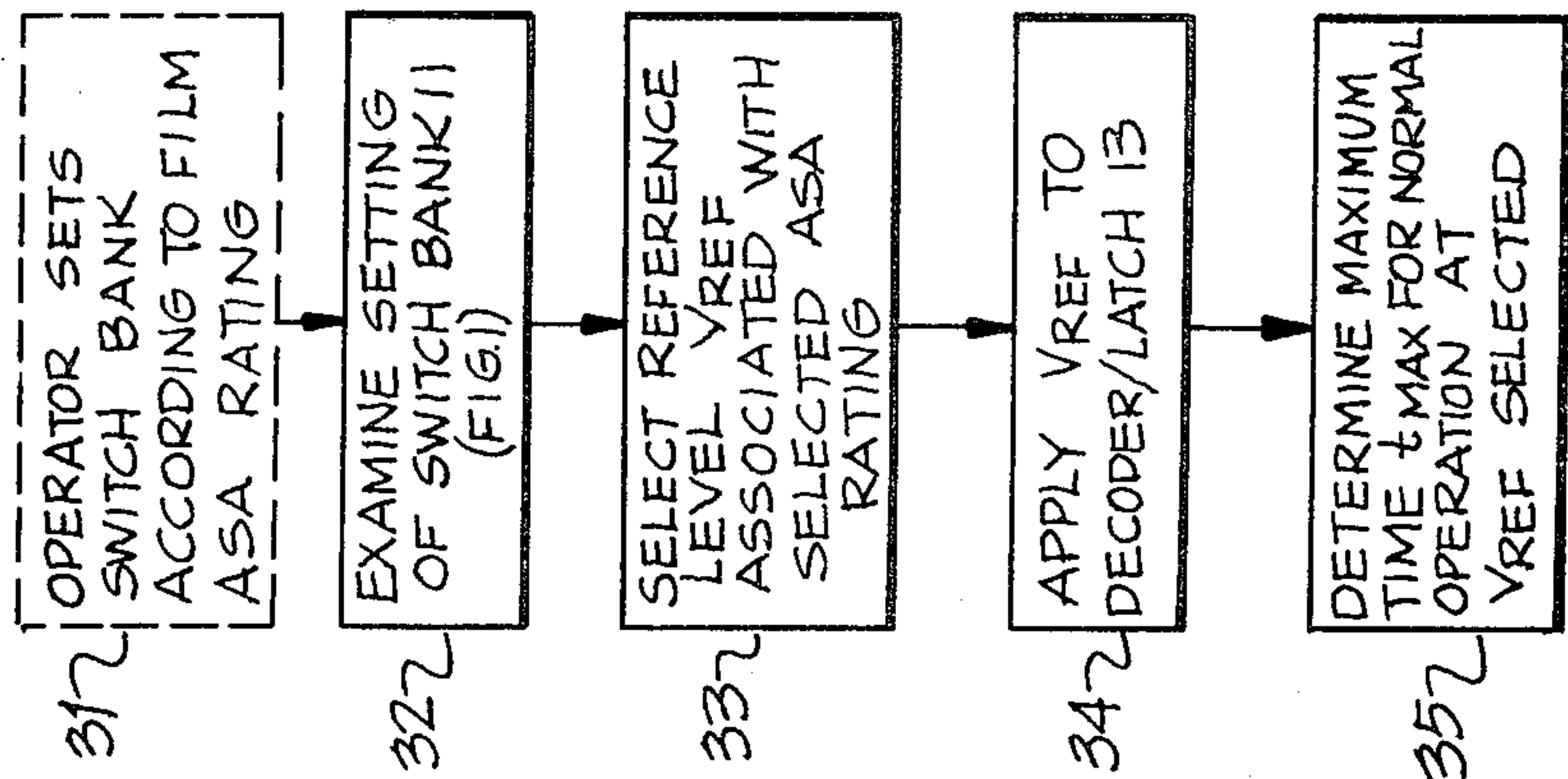


FIG. 5

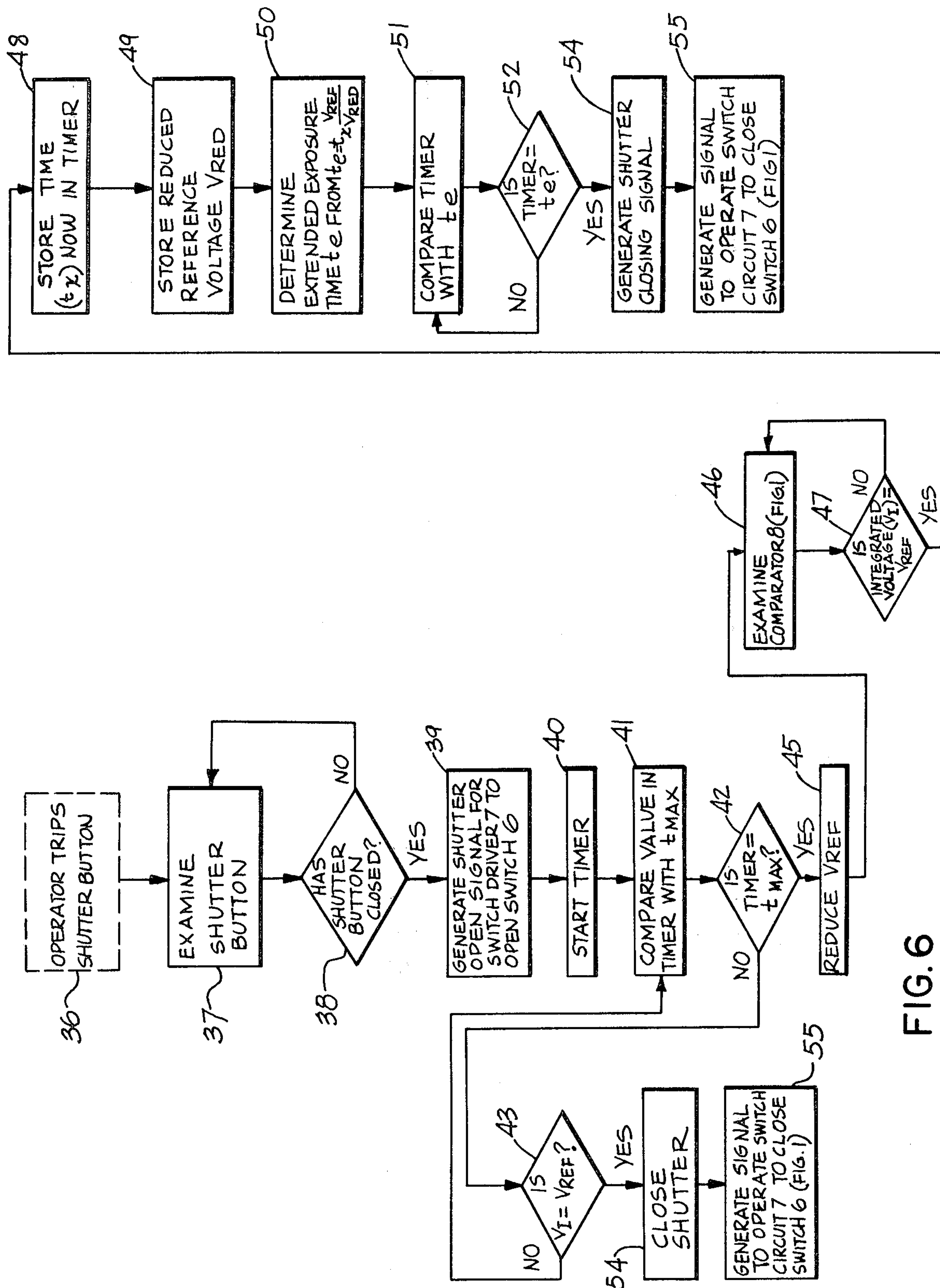


FIG. 6

INTEGRATING TIME DETECTOR FOR PHOTOGRAPHIC APPARATUS

BACKGROUND OF THE INVENTION

The invention relates to an integrating time detector for use in a photographic apparatus.

An integrating circuit is used, for example, in a photometric circuit of a photographic apparatus, in particular, in a direct photometric circuit. The integrating circuit is adapted to integrate a photocurrent which is produced by a photoelectric transducer element in response to the incidence of reflected light from an object being photographed thereon in order to determine an exposure period which corresponds to the light from the object. Such circuit suffers from the disadvantage that the integration cannot be performed over an increased length of time since the integrating period is limited by the characteristic of an integrating capacitor used, for example, the leakage current thereof. When the integrating circuit is used in a photographic camera, this means that the combination cannot allow an exposure period for the camera which has an increased value. On the other hand, when such integrating circuit is used in a situation involving a low level of illuminance as when taking a picture with a microscope, an inconvenience is experienced that it takes a long integrating time.

SUMMARY OF THE INVENTION

It is an object of the invention to eliminate the described disadvantages of the prior art by providing an integrating time detector for a photographic apparatus which is capable of calculating a required integrating time interval at an earlier time, even for an increased length of integrating time, by changing a reference voltage against which an integrated voltage is compared to determine the integrating time interval.

In accordance with the invention, a reference voltage against which an integrated voltage is compared is changed to permit the calculation of a required integrating time interval at an earlier time, if the latter has an increased duration, before the actual integrating time interval lapses. In this manner, the adverse influence of the leakage current from an integrating capacitor is eliminated even when an integrating time interval of an increased length is involved. When taking a picture with a microscope where the illuminance is of a low level to necessitate an increased length of integrating time, the required integrating time interval can be calculated at an earlier time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the electrical circuit of the integrating time detector according to one embodiment of the invention;

FIG. 2 graphically illustrates the choice of a reference voltage, illustrating the operation of the detector shown in FIG. 1;

FIG. 3 is a diagrammatic view of the integrating time interval which can be detected by the detector of FIG. 1 as a function of the film speed and the illuminance;

FIG. 4 is a block diagram showing the computer of FIG. 1 in greater detail; and

FIGS. 5 and 6 are flow diagrams useful for describing the operations performed by the computer of FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown the electrical circuit of an integrating time detector according to the invention. Specifically, it includes a photoelectric transducer element 1 which is responsive to light from an object being photographed to produce an output photocurrent, which is in turn integrated by an integrating circuit 2. An output from the integrating circuit 2 or an integrated voltage is fed to a voltage comparator 8, which is also fed with a reference voltage from a calculation and control circuit 9. The integrating circuit 2 is associated with a switch driver 7 which controls the discharge of the integrated voltage.

More specifically, the integrating circuit 2 includes an operational amplifier 3 having an input which is fed with the output photocurrent from the transducer element 1, with an integrating capacitor 4 connected across the input and the output terminal thereof and with a series combination of a discharge resistor 5 and a switch 6 connected in shunt with the capacitor. The purpose of the series combination of the resistor 5 and the switch 6 is to clear or discharge the integrated voltage across the capacitor whenever the detector has determined the integrating time interval.

The calculation and control circuit 9 comprises a bank of switches 11 which are utilized to preset a film speed, an interface circuit 12 which responds to the film speed information supplied from the bank 11 by converting it into a voltage level which is compatible with a subsequent computer 10, a decoder/latch 13 which receives and latches various control information from the computer 10 through an address bus 10A and a data bus 10B and which decodes such information, a digital-analog converter 14 which is supplied with digital information representing a reference voltage from the decoder/latch 13 and converts it into an analog reference voltage, and a display 15 for displaying information indicative of the integrating time interval which is supplied from the decoder/latch 13. The analog reference voltage which is produced by the D-A converter 14 is applied to one input of the voltage comparator 8 where it is compared against the integrated voltage from the circuit 2 which is applied to the other input thereof. When the integrated voltage is equal to or exceeds the analog reference voltage, the comparator produces an output signal, which is fed to the computer 10. It will be understood that on the basis of film speed information supplied from the bank of switches 11, the computer 10 develops a reference voltage, which is supplied to the comparator 8 through the A-D converter 14, and monitors the comparison result to determine the integrating time interval. When the integrating time interval is determined, the computer 10 delivers an integration complete signal which is fed to the switch driver 7, causing the latter to close the switch 6 in the integrating circuit 2 to thereby discharge the integrated voltage across the capacitor 4 through the discharge resistor 5. This completes an integrating operation, and the circuit is ready to initiate another cycle of operation. It is to be understood that the decoder/latch 13 in the calculation and control circuit 9 is adapted to deliver a control signal, shown at 17, which is effective to close a shutter, not shown, at the termination of the integrating time interval determined by the computer 10.

It is a feature of the integrating time detector shown in FIG. 1 that the reference voltage which is supplied to one input of the voltage comparator 8 is changed under

the control of the computer 10. The change in the reference voltage also depends on the film speed which is supplied from the bank of switches 11. The manner in which the computer 10 changes the reference voltage to permit an earlier determination of the integrating time interval for an increased length of integrating time interval will be described below with reference to FIG. 2.

In FIG. 2, the ordinate represents an integrated voltage V plotted against an integrating time t shown on the abscissa. It is to be understood that the illustration in FIG. 2 corresponds to the application of the integrating time detector of FIG. 1 to a photometric circuit of a photographic camera which is of direct photometry type. In the illustration of FIG. 2, a reference voltage V_{16} represents a reference voltage corresponding to a film sensitivity of ASA 16 while a reference voltage V_{3200} corresponds to a film sensitivity of ASA 3200. The reference voltage V has an increased magnitude for a low film sensitivity and has a low magnitude for a high film sensitivity. In FIG. 2, the photometry is permitted for a range of film sensitivities from ASA 16 to 3200. A minimum integrating time interval t_{min} and a maximum integrating time interval t_{max} are indicated on the abscissa, and indicate the minimum and the maximum integrating time interval, respectively, which can be permitted during the direct photometry. In a conventional photometric circuit, a perfect photometry is only permitted during an exposure period which corresponds to an integrating time interval from t_{min} to t_{max} . For an integrating time interval greater than t_{max} , the leakage current of the integrating capacitor has an adverse influence upon the integrating action, preventing a proper exposure period from being determined. In addition, the determination can only be made after the termination of such integrating time interval of an increased length.

In FIG. 2, the origin is defined by an integrating time interval t_0 and an integrated voltage of zero. A number of rectilinear lines indicative of integrated voltages V_{Lmax} , V_f , $V_{Lm(16)}$, V_e and V_{Lmin} are shown extending from the origin and corresponding to a different value of illuminance L as a parameter. Of different the values of the illuminance L_{max} , L_f , $L_{min(16)}$, L_e and L_{min} , L_{max} represents the maximum illuminance and L_{min} the minimum illuminance which can be determined photometrically. For purposes of illustration, it is assumed that the illuminance has a level L_f and the ASA film sensitivity is α . In this instance, the reference voltage V will have a value V_α shown on the ordinate. A proper exposure period is determined by photometry as the curve V_f representing the integrated voltage for the illuminance L_f crosses the reference voltage V_α or at a point of intersection f of the integrated voltage V_f with a horizontal line extending from the value V_α on the ordinate. It will be seen that since the integrating time interval t_f in this instance is located intermediate the minimum and the maximum value t_{min} and t_{max} , it can be calculated by the usual direct photometry technique, and hence it is unnecessary to change the reference voltage V_α .

However, considering the illuminance of L_e and the reference voltage of V_α , it will be noted that the rectilinear line representing the integrating voltage V_e for the illuminance L_e cannot cross the horizontal line corresponding to the reference voltage V_α before the maximum integrating time interval t_{max} is reached. In other words, the line representing the integrated voltage V_e crosses the horizontal line corresponding to the reference voltage V_α at a point e which goes beyond the

maximum time interval t_{max} . The integrating time interval corresponding to the point of intersection e is t_e . Hence, it requires a longer period of time than the maximum time interval t_{max} to determine the integrating time interval t_e by the usual direct photometry technique. In such instance, the integrating action is influenced by the leakage current of integrating capacitor to prevent a proper exposure period from being determined, as mentioned previously. In accordance with the invention, a rectilinear line \overline{ab} as shown in FIG. 2 is defined. Specifically, the line \overline{ab} joins a point a on the horizontal line corresponding to the reference voltage V_{16} with a point b on another horizontal line corresponding to the reference voltage V_{3200} . By utilizing the rectilinear line \overline{ab} , the integrating time interval is determined prematurely to eliminate the influence of the leakage current of the integrating capacitor. Any reference voltage corresponding to a point on the line segment \overline{ab} is stored in the computer 10 and is supplied to the voltage comparator 8.

Continuing the description of the example for the illuminance L_e and the reference voltage V_α , a value corresponding to the ASA film speed α is established in the bank of switches 11 in the integrating time detector of FIG. 1, and such value is supplied to the computer 10 through the interface circuit 12. The computer 10 determines the reference voltage V_α corresponding to the ASA speed by utilizing a value stored in an internal memory which is manipulated under a program control, and supplies it on the data bus 10B to the decoder/latch 13 under the control of the address bus 10A. In response thereto, D-A converter 14 converts it into a corresponding analog reference voltage, which is then applied to one input of the comparator 8. As the photometry is initiated, the integrated voltage V_e supplied to the other input of the voltage comparator 8 from the integrating circuit 2 is compared against the reference voltage V_α . As mentioned previously, the integrated voltage V_e cannot cross the horizontal line corresponding to the reference voltage V_α before the maximum integrating time interval t_{max} is reached. However, when an integrating time of t_e is reached after the initiation of the photometry, the horizontal line corresponding to the reference voltage V_α crosses the line segment \overline{ab} at a point of intersection c . In addition to storing the reference voltage response corresponding to the line segment \overline{ab} , the computer 10 stores the value of the reference voltage V_α which is being utilized for the photometry as well as the value of any corresponding film speed, so that at the integrating time t_e , it readily detects integrating time t_e under a program control, and changes a subsequent reference voltage into a modified value which varies in accordance with the response to the line segment \overline{ab} . Accordingly, the reference voltage which varies along the line segment \overline{ab} is fed to the voltage comparator 8 through the decoder/latch 13 and the D-A converter 14. The reference voltage gradually changes along the line segment \overline{ab} in a direction indicated by an arrow k . At time t_j , the integrated voltage V_e assumes a value $V_{e(j)}$ corresponding to a point e_j on the line representing the integrated voltage V_e , while the reference voltage supplied to the voltage comparator 8 under the control of the computer 10 assumes a value V_j corresponding to a point j on the line segment \overline{ab} . Hence, the output from the voltage comparator 8 does not change at this time. However, as the time passes and the integrating time of t_d is reached, the integrated voltage crosses a reference voltage V_d at a

point of intersection d, whereby the voltage comparator 8 produces an output. The output is fed to the computer 10, and the corresponding integrating time interval t_d is stored in the computer 10.

When the integrating time interval t_d representing the intersection of the integrated voltage with the modified reference voltage is detected, the computer 10 calculates a true integrating time interval t_e for the illuminance L_e and the initial reference voltage V_a , utilizing the time interval t_d , the corresponding reference voltage V_d , the initial reference voltage V_a and the rectilinear line representing the integrated voltage V_e for the illuminance L_e as follows:

$$t_e = \frac{V_a}{V_d} t_d$$

Representing the reference voltage corresponding to the line segment \overline{ab} by $V=f(t)$, the reference voltage V_d can be uniquely obtained as $V_d=f(t_d)$. Hence the equation (1) can be rewritten as follows:

$$t_e = \frac{V_a}{f(t_d)} t_d$$

From the above discussion, it will be appreciated that the true integrating time interval t_e can be easily calculated at an earlier time t_d which is less than the maximum integrating time interval t_{max} even though the integrating time interval t_e exceeds the maximum time interval t_{max} . In this manner, the adverse influence of the leakage current of the integrating capacitor can be avoided.

Considering the rectilinear line representing the integrated voltage V_{Lmax} for the maximum illuminance L_{max} which can be determined photometrically, it is seen that it crosses the reference voltage V_{16} corresponding to the ASA speed 16 at a point of intersection g to indicate an integrating time interval of t_g , and also crosses the reference voltage V_{3200} corresponding to the ASA film speed 3200 at a point of intersection h to indicate a minimum integrating time interval t_{min} . Considering the rectilinear line representing the integrated voltage V_{Lmin} for the minimum illuminance L_{min} , it crosses the reference voltage V_{3200} corresponding to the ASA film speed 3200 at a maximum integrating time interval t_{max} . The rectilinear line representing the integrated voltage $V_{Lm(16)}$ for the illuminance $L_{min(16)}$ crosses the reference voltage V_{16} corresponding to the ASA film speed 16 at the maximum integrating time interval t_{max} .

FIG. 3 diagrammatically illustrates the operable range of the integrating time detector described above in connection with FIGS. 1 and 2, as a function of the ASA film speed and the illuminance. The abscissa represents the ASA film speed from 16 to 3200 while the ordinate indicates the integrating time interval which can be detected. On the ordinate, the minimum integrating time interval t_{min} is shown topmost, and the maximum time interval t_{max} which can be detected by the direct photometry technique is indicated below that. The maximum integrating time interval T_{max} which can be detected by the integrating time detector of the invention is shown at the bottom of the diagram. Different levels of illuminance L_{max} , $L_{min(16)}$, L_{min} are shown by arrows which are directed obliquely upward to the left, and it is to be understood that the same value of illuminance prevails along the direction which is indi-

cated by the respective arrow. It will be seen that a region A shown in FIG. 3 represents the range where the photometry of a conventional integrating circuit of direct photometry type is operable while a region B represents a range which can be detected by the integrating time detector of the invention. Thus, the region A extends between the minimum and the maximum integrating time interval t_{min} and t_{max} for ASA film sensitivity from 16 to 3200 for illuminances from L_{max} to L_{min} . By contrast, the maximum integrating time interval which can be detected is extended to a value T_{max} when the integrating time detector of the invention is used.

The computer 10 of FIG. 1 is shown in greater detail in FIG. 4 and comprises a central processor unit 20 comprising: a microprocessor 21, clock generator 22, and system controller 23 including bi-directional bus drivers and a system control; a random access memory (RAM) 24 and a programmable read-only memory (PROM) 25. RAM 24 and PROM 25 are coupled to CPU 21 by data bus 26. Data stored in PROM 25 and RAM 24 is accessed by addressing the desired memory locations through address bus 26 and enabling the data transfer to CPU 21 by control bus 27. Data is read into RAM 24 in a similar fashion. The CPU is preferably a Model 8085A; the RAM is preferably a Model 8156 with I/O, counter and timer; and the PROM is preferably a Model 8755A with I/O, all manufactured by Intel.

The operations performed by computer 10 are shown by the flow diagrams of FIGS. 5 and 6 wherein the initial conditions preparatory to a photographing operation are established in the manner shown in FIG. 5. The film rating is selected by setting the switch bank (31). Computer 10 examines the setting (32) and selects the reference voltage level V_{REF} associated with the ASA rating of the film (33). The reference voltage is applied to decoder/latch 13 (33). D/A converter 14 converts the digital value to an analog level to enable comparator 8 to compare V_{REF} to the integral voltage developed by operational amplifier 3.

The computer 10 then determines the maximum time t_{max} during which a perfect photometry may be performed, in accordance with curve \overline{ab} (35).

The electronic control of the photographing operation is in accordance with the flow diagram of FIG. 6 wherein the operation is initiated by operation of a shutter button (36) which trips the camera shutter (not shown for purposes of simplicity). The computer 10 detects the closure of the shutter button (37, 38) to develop a signal (39) for operating switch driver 7 to open switch 6; and to start a timer (40) which is typically a register in CPU 20 which is periodically incremented, as is conventional. The value in the timer is periodically compared with the value t_{max} previously calculated (41). If the integrated signal reaches the value V_{REF} before the timer reaches t_{max} , a normal photometry is performed by closing the shutter (42, 43, 54). A signal is developed to operate switch driver circuit 7 to close switch 6 preparatory to the next photographing operation (55).

If the timer value reaches t_{max} (42) and V_I has not yet reached V_{REF} then V_{REF} is reduced (45) in accordance with the slope of curve \overline{ab} . The comparator 8 is periodically examined (46). When $V_I = V_{REF}$ (reduced), i.e. V_{RED} (47) the time (t_x) in the timer is stored (48) and the reduced V_{REF} value is stored (49). These values are utilized, together with the original V_{REF} , to calculate

the extended time t_e (50) in accordance with the equation $t_e = t_x V_{REF}/V_{RED}$. Thus, the extended time t_e is determined before its actual occurrence, avoiding the need for relying on the limited capability of the integrating element 4.

The timer is periodically compared with the value t_e (51). When the timer value equals t_e (52), the shutter closing signal is generated (54) and the signal for closing switch 6 is generated (55).

Thus a proper photometry is obtained regardless of the limitations of the integrating element 4 and before the actual extended time occurs.

A latitude of modification, change and substitution is intended in the foregoing disclosure, and in some instances, some features of the invention will be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

What is claimed is:

1. An integrating time detector for a photographic apparatus, comprising:
 - integrating means for integrating an input signal to provide an integral signal;
 - means for producing a given reference signal for comparison with the integral signal until a given time interval is reached, and for producing a changing reference signal which changes as a given function of time after the given time interval if the integral signal does not reach the given reference value within the given time interval, thereby detecting a time when the integral signal coincides with the changing reference voltage, said means calculating an integrating time interval corresponding to the given reference signal based on the time when the coincidence is detected, the given reference signal and the given function of time; and
 - comparison means for comparing the integral signal outputted from the integrating means against the reference signal produced by the calculating means to output a coincidence signal whenever the integrating and reference signals coincide with each other.
2. An integrating time detector according to claim 1, further including means for presetting information which corresponds to the given reference signal against which the integral signal from the integrating means is compared, the calculating means producing the given reference signal which corresponds to the preset information for a given time interval which corresponds to the given reference signal.
3. An integrating time detector according to claim 1, further including a display connected to the calculating means for displaying an integrating time interval derived by the calculating means.
4. An integrating time detector according to claim 1 in which the calculating means comprises a computer.
5. An integrating time detector according to claim 4 in which the calculating means additionally comprises a decoder/latch for latching and decoding various information supplied from the computer, and a digital-analog converter for converting digital information from the decoder/latch which corresponds to the reference signal and for converting the digital information into a corresponding analog reference signal for supply to the comparison means.
6. An integrating time detector according to claim 1, further including an interface circuit which converts

information preset by the information preset means into a signal compatible with the calculating means.

7. An integrating time detector according to claim 1 in which the integrating means comprises an integrating, operational amplifier having its one input supplied with an input signal corresponding to an electrical conversion of light from an object being photographed which is photometrically determined, an integrating capacitor connected across said one input of the operational amplifier and the output terminal thereof, and a series circuit including a resistor and a switch connected in shunt with the integrating capacitor, and in which the comparison means comprises a comparison, operational amplifier having its one input connected to the output of the first mentioned operational amplifier and having its other input connected to receive the reference signal from the calculating means, an output signal from the comparison, operational amplifier being applied to the calculating means.

8. A time detector for detecting the time interval for a photographing operation comprising:

- first means for generating a signal which is a function of light received by said first means, responsive to a shutter opening;

- integrating means for integrating said signal;

- second means for providing an initial reference level; said second means including third means for altering said reference level after a first predetermined time interval;

- comparator means for comparing said integrated signal against said reference level to generate an output;

- said second means including fourth means for determining the time for closing the shutter to provide a proper photographing operation responsive to the time said comparator means generates an output and responsive to the initial reference level.

9. A method for determining the time for a proper photographing interval to operate a shutter comprising the steps of:

- providing a first reference level representative of the film speed of the film used for photographing;

- generating a signal representative of the light being reflected from the image being photographed, responsive to the opening of the shutter;

- integrating said signal;

- determining a first predetermined time in accordance with said first reference level;

- altering said first reference level at a predetermined rate upon the occurrence of said first predetermined time; p1 determining a first time interval when the integrated signal equals the altered reference level;

- determining the time needed for a proper photographing operation based on the first time interval, the first reference level and the reduced reference level; and

- closing the shutter responsive to the calculated elapsed time.

10. A method for operating a shutter to provide a proper photographing operation comprising the steps of:

- providing a reference level responsive to the film speed of the film being used for the photographing operation;

- generating a signal representing the light reflected from the image being photographed responsive to the opening of the shutter;

integrating said signal;
 altering the reference level at a predetermined time
 prior to the prior time interval required;
 calculating the required time interval for closing the
 shutter at a time prior to the required time respon- 5
 sive to the time required for said integrated signal
 to equal said reduced value;
 closing said shutter when said calculated time has
 elapsed.

11. A method for determining an extended exposure 10
 interval for operating a shutter including a timer and
 photometry means, comprising the steps of:

starting the timer responsive to opening of the shut-
 ter, said photometry means also being activated
 responsive to the shutter opening to develop a 15
 signal level representative of light reflected from
 the object being photographed;
 determining a reference level and maximum time
 interval for an unextended photographing opera-
 tion determined by the film ASA rating; 20
 reducing said reference level when said maximum
 time interval is reached;
 comparing the output level of said photometry means
 against said reference level;
 determining the extended time interval for the photo- 25
 graphing operation when said levels compare,
 based upon the original reference level, the re-
 duced reference level and the time when said levels
 compare.

12. Determining a time interval for a photographing 30
 operation through the employment of a photometry

circuit which generates an integrated signal responsive
 to the light level sensed by the photometry circuit in-
 cluding the steps of:

determining an initial threshold level in accordance
 with the characteristics of the film being used in the
 photographing operation;
 successively reducing the threshold level a predeter-
 mined time after the initiation of a photographing
 operation;
 terminating the photographing operation responsive
 to the integrated signal reaching the threshold level
 prior to the predetermined time; and
 determining the extended time required for the inte-
 grated signal to reach the initial threshold level
 responsive to the integrated signal reaching the
 reduced threshold level.

13. The method of claim 12 further comprising the
 step of generating a terminating signal for terminating
 the photographing operation at the extended time cal-
 culated.

14. The method of claim 12 wherein the step of deter-
 mining the extended time further comprises the step of
 noting the time when the integrated signal reaches the
 reduced threshold level and determining the extended
 time (t_{ex}) in accordance with the relationship $t_{ex} = V_f$
 V_i/t_i where V_f is the signal level representing the char-
 acteristic of the film, V_i is the instantaneous value of the
 reducing signal and t_i is the time at which the integrated
 signal reaches the value of the reducing signal V_i .

* * * * *

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 4,329,030
DATED : May 11, 1982
INVENTOR(S) : Mamoru Aihara, et al.

It is certified that error appears in the above—identified patent and that said Letters Patent is hereby corrected as shown below:

column 3, line 42, "Of different the values" should read
--Of the different values--.

Column 4, line 40, "voltage V_{60} " should read --voltage V_a --.

Column 4, line 64, "ab" should read -- \overline{ab} --.

Column 8, lines 50-51 "predetermined time p1" should read
--predetermined time.--

Signed and Sealed this

Eighth Day of February 1983

[SEAL]

Attest:

GERALD J. MOSSINGHOFF

Attesting Officer

Commissioner of Patents and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 4,329,030
DATED : May 11, 1982
INVENTOR(S) : Mamoru Aihara, et al.

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Column 3, line 42, "Of different the values" should read --Of the different values--.

Column 4, line 40, "voltage V_{60} " should read --voltage V_a --.

Column 4, line 64, "ab" should read -- \overline{ab} --.

Column 8, lines 50-51, "predetermined time pl" should read --predetermined time;--

This certificate supersedes Certificate of Correction issued February 8, 1983.

Signed and Sealed this

Fourteenth **Day of** *June 1983*

[SEAL]

Attest:

DONALD J. QUIGG

Attesting Officer

Acting Commissioner of Patents and Trademarks